

# ***Fatigue & Human Machine Interface in Unmanned Aerial Systems***

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**U.S. AIR FORCE**

**NTSB Unmanned Aerial Systems  
Human Factors Sub-group**

**Washington, DC  
30 April, 2008**

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Brooks City-Base, Texas**







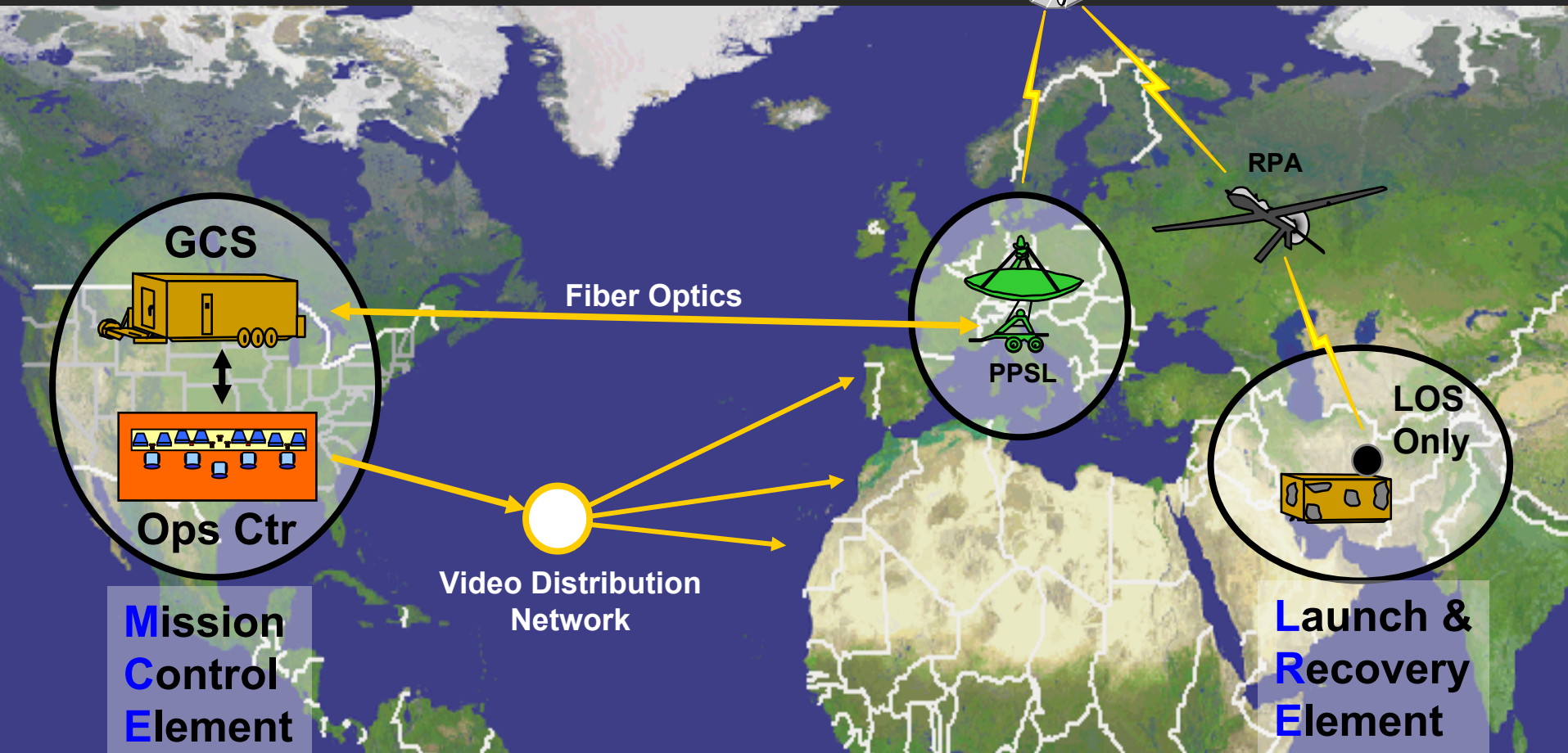
# Remote Split Operations



CONUS

Ku Satellite

In Theater

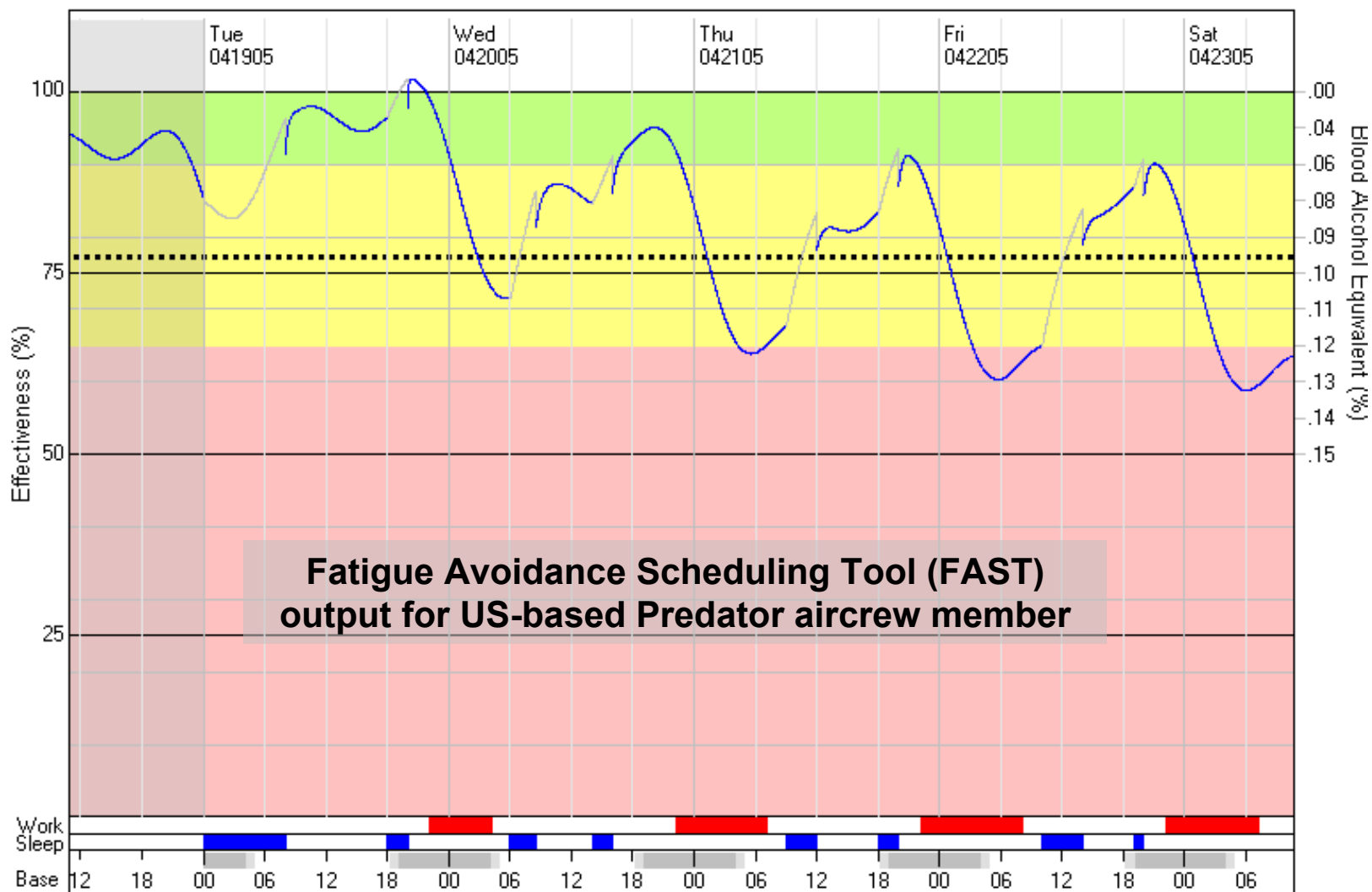




# Results - Fatigue

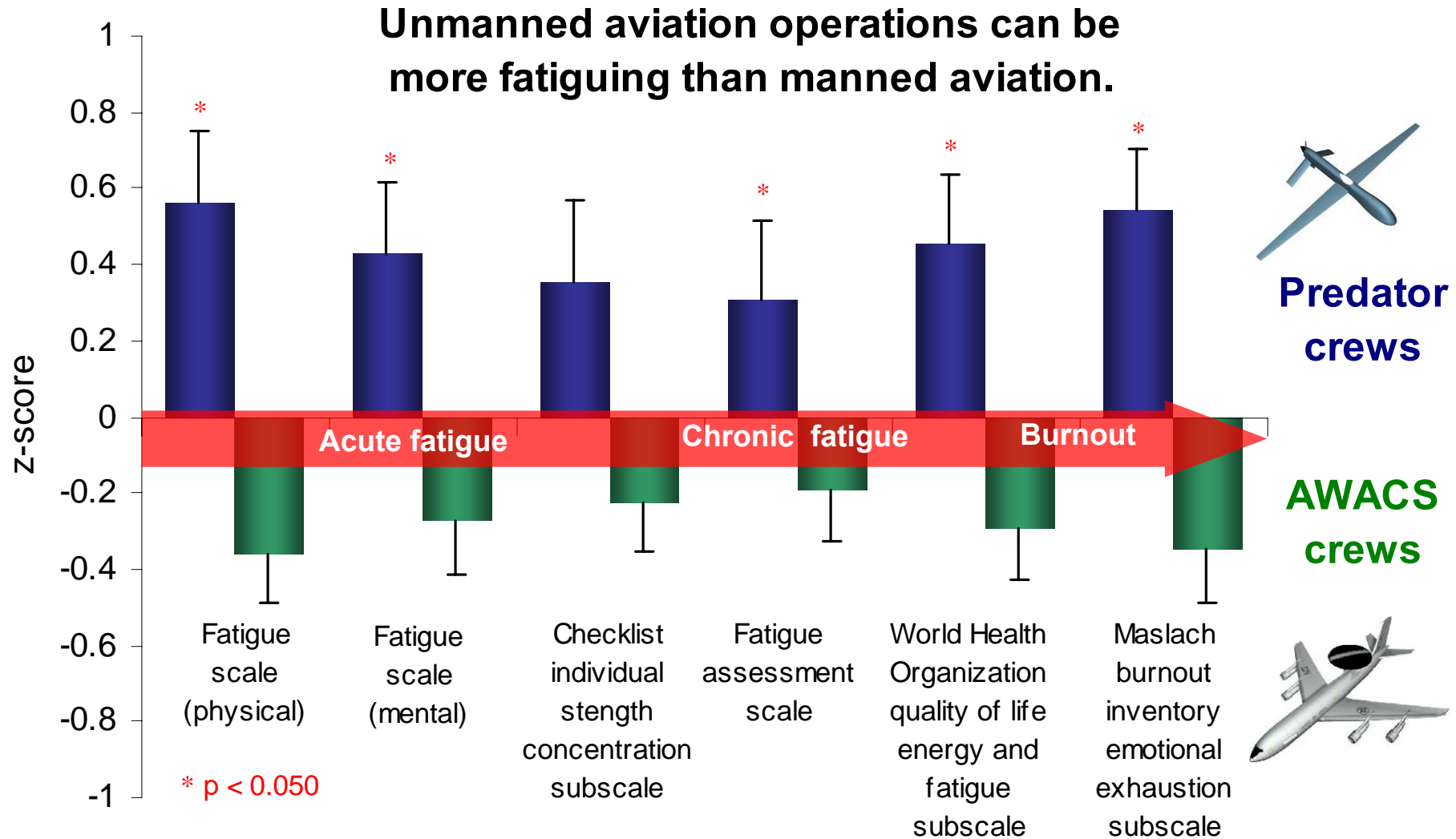


## Work Effectiveness During Night Shift



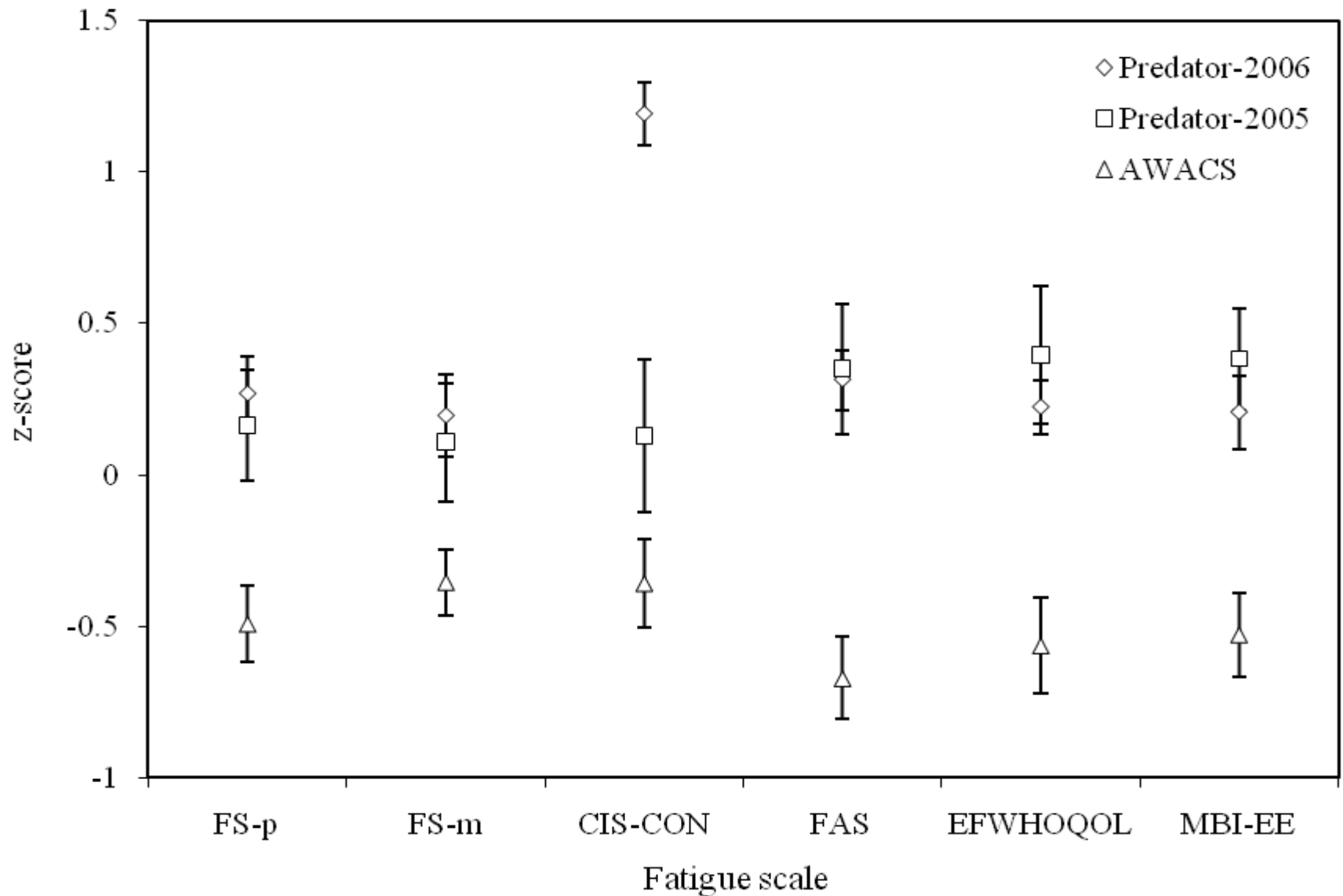


# Jetlag without leaving the ground





# Manpower Constraint

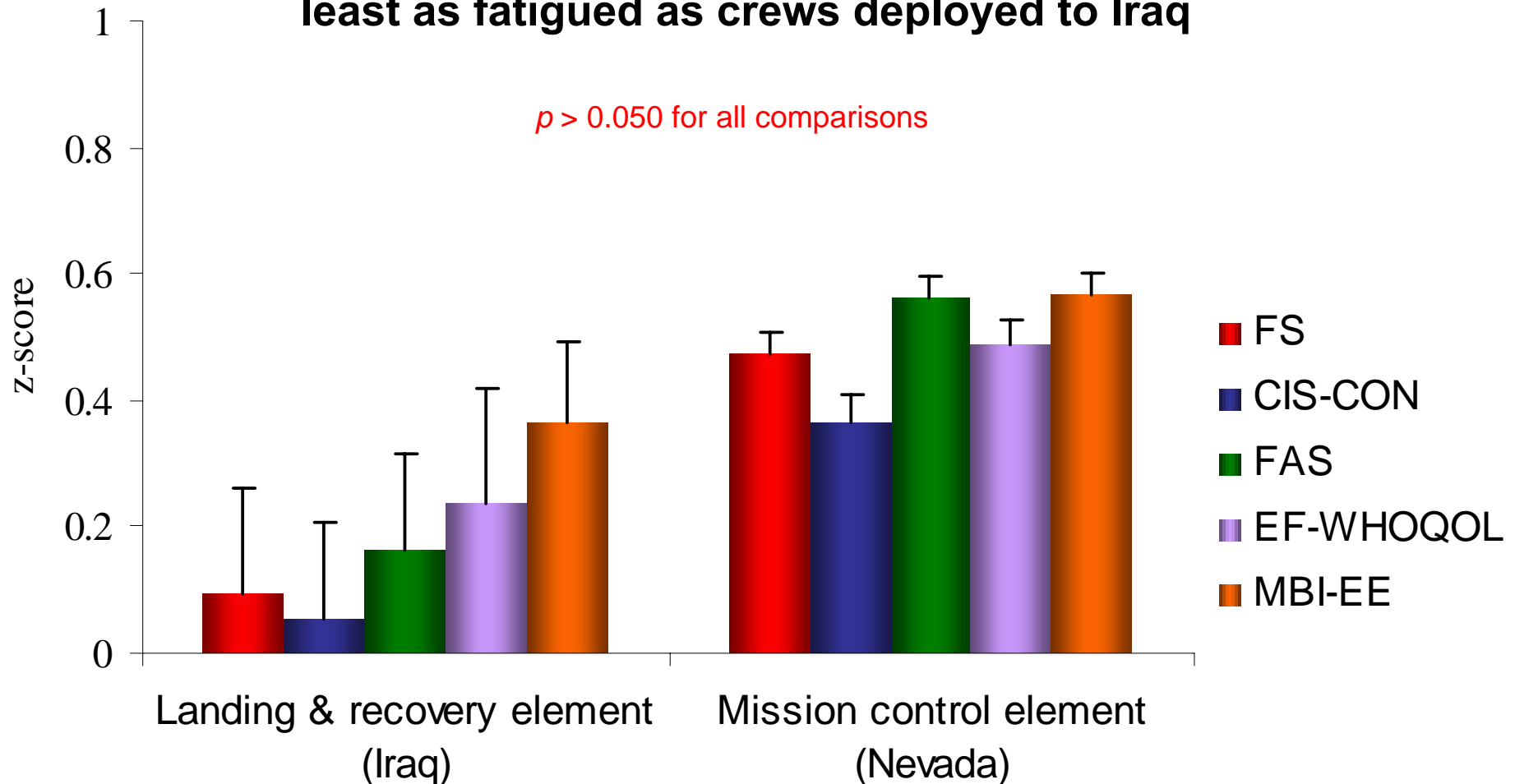




# Better off deployed



**Predator crews teleoperating in Iraq are at least as fatigued as crews deployed to Iraq**







# Toll of Shiftwork



## Results of survey looking at impact of work schedule on life activities

Life activity	Proportion responding yes		$\chi^2$ -value	p-value
	Predator	AWACS		
Inadequate time with spouse	<b>0.79</b>	0.25	17.43	< 0.001
Inadequate time with children	<b>0.75</b>	0.32	7.90	0.005
Inadequate time with friends	<b>0.67</b>	0.22	14.03	< 0.001
Inadequate time for recreational activities	<b>0.83</b>	0.18	27.18	< 0.001

**Finding:** Predator crewmembers are limited in accessing social support networks.



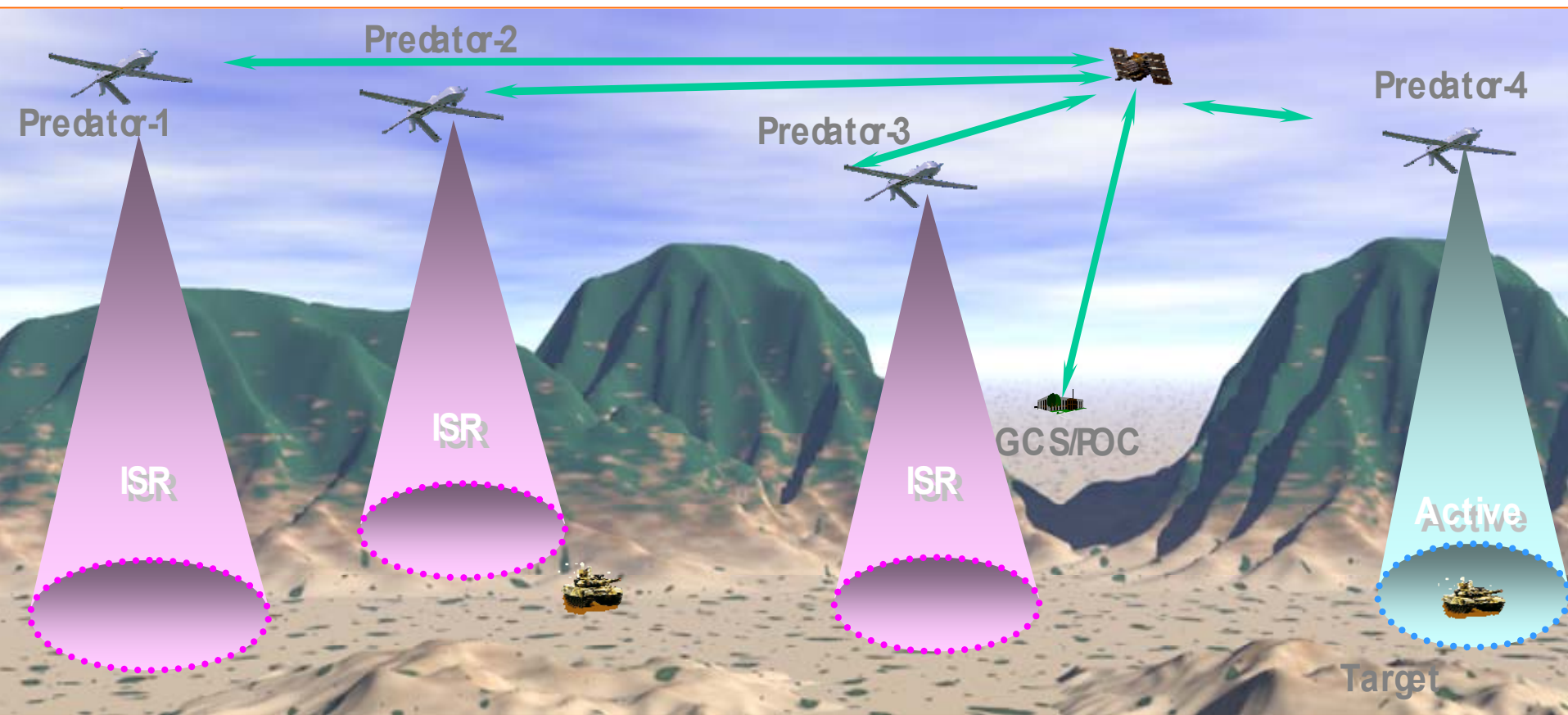


# What can the civilian sector learn from the Predator experience?





# Remote Split Operations







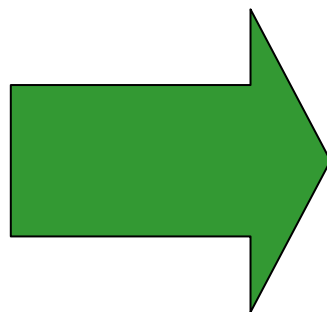
# Display Improvement



## Legacy VIT Graphic

1: 914 Engine and Electronics Data

Engine Speed	3481	RPM	MAP	23.6	in Hg
EGT 1	982	°F	EGT 3	981	°F
EGT 2	976	°F	EGT 4	971	°F
Water Temp	172	°F	CHT	180	°F
Oil Temp	214	°F	Oil Press	78.0	psi
Oil Level	66	%	Fuel Press	6.0	psi
Turbo Oil Temp	218	°F	Wastegate Fbk	0	%
Fuel Level #1	52	% or lb	Fuel Level #2	59	% or lb
F Flow Rate	3.0	lb/hr	28V Bus @PCM	27.9	V
Fuel Burned	16.00	lb	Bat 1 Volt	15.0	V
Fuel Xfer	38.64	lb	Bat 2 Volt	15.0	V
Uplink Sig 1	56.7	%	Dnlink Sig 1	72.0	%
Uplink Sig 2	77.3	%	Dnlink Sig 2	86.0	%
MCT	120	°F	Altnr Temp	210	°F
Atmos Temp	17	°C	System Amp	18.8	A
True Airspd	8.6	kt	Pwr Sup 1 Amp	0.9	A
Ground Speed	8.7	kt	Net Bat Amps	19.0	A
Density Alt.	5604	ft	Cool Fan Amp	0.0	A

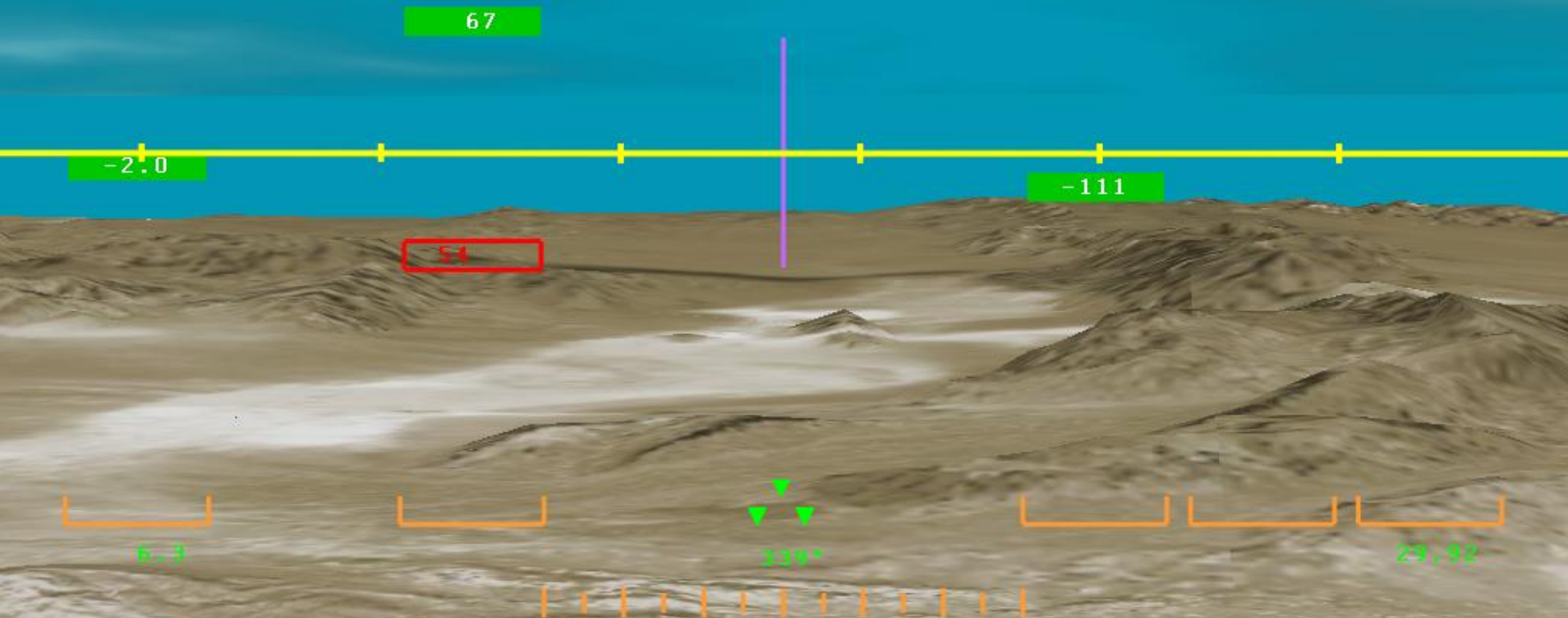


## Proposed Improvement



Freeze Mode: Preset Load Airspd>40k:

AOA	Air Speed	VSI	RPM/ MAP	Alt MSL
			3932	9874
			16.5	





7.6  
AOA

KIAS

01 02 03 04  
026

20

20

5500  
RPM

32.5  
MAP

ALT MSL

90

84

80

8

15

15

10

10

5

5

2000

1840

1500

8

TAS 87

GS 87

4.50

1200

Mode 4

VV 4

1.16

CH01

118.325

29.95

MISSION  
00:00:31

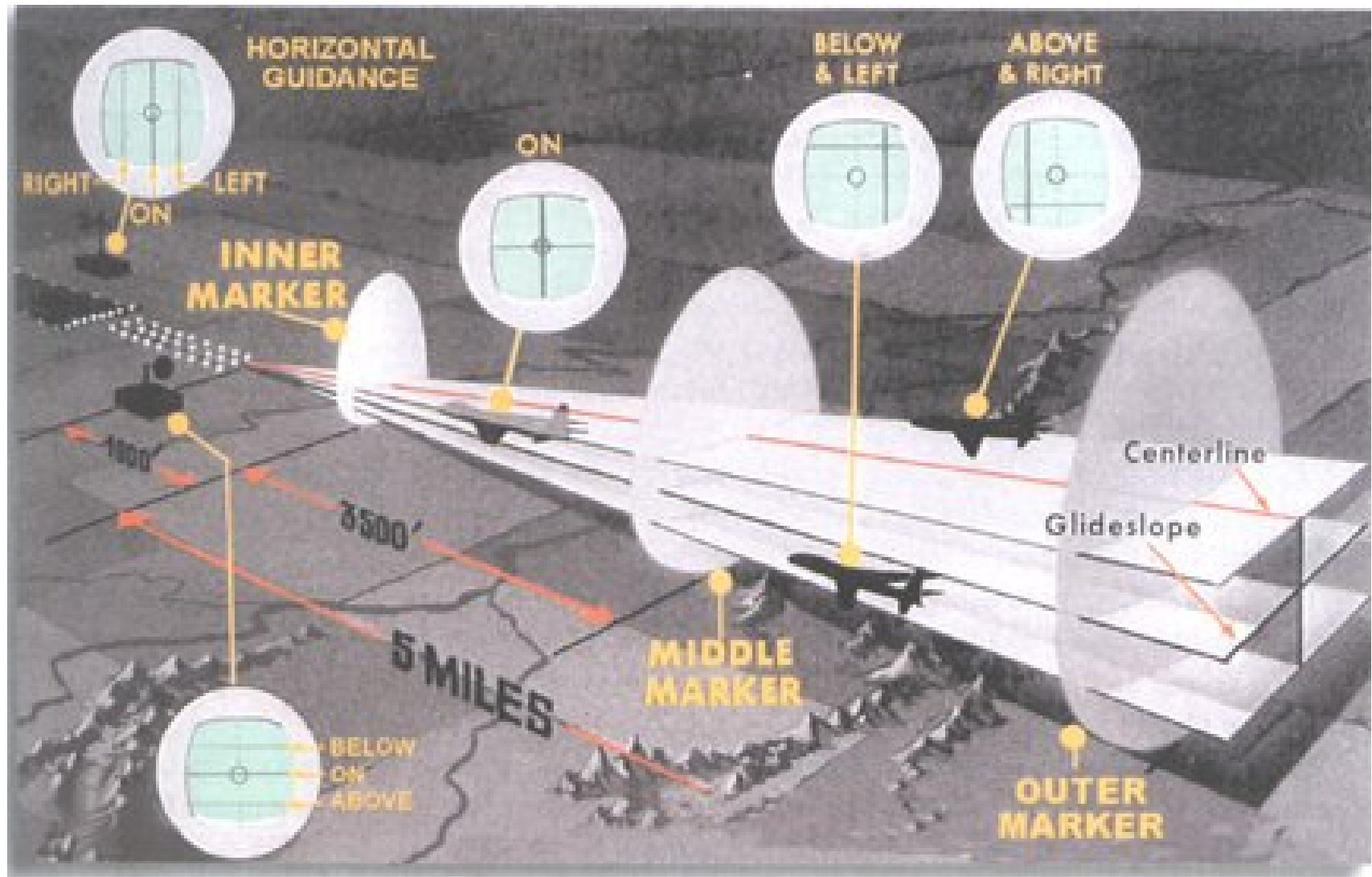
CLK (GMT)  
00:00:00

STOPWATCH  
00:00:00

POWERUP  
00:00:31



# *Instrument Landing System*

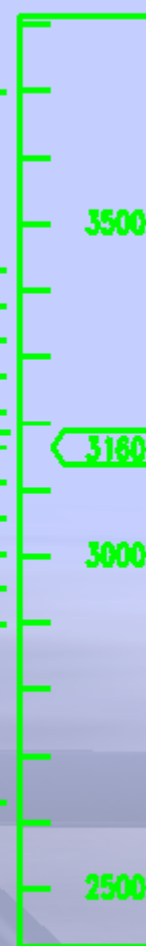
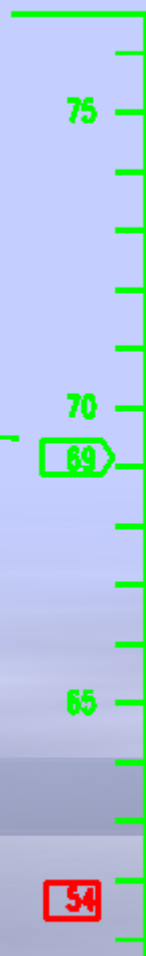






KIAS

ALT MSL



5 5

5 5

10 10



TAS 72  
GS 72

WV -314  
G 1.03

0.48

1200 Mode 4

CH01 110.325

30.00



# *Landing Cognitive Task Analysis*



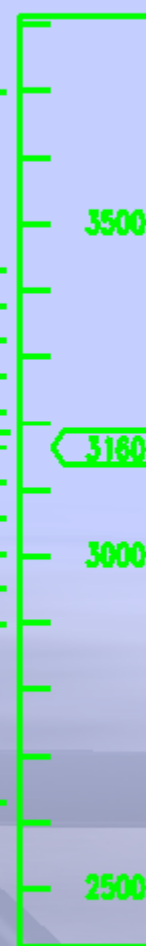
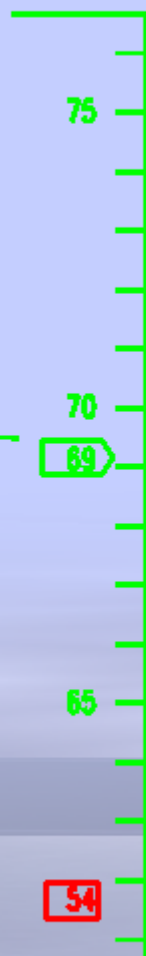
## **What information does a Predator pilot need?**

- **Aircraft attitude**
- **Location of the runway**
- **Deviation from runway centerline**
- **Deviation from desired glideslope**
- **Deviation from desired approach airspeed**
- **Relative closure of landing gear & runway**
- **VSI < 480 ft/min in flare**
- **Position of nose gear relative to main gear**
- **Position on runway (first  $\frac{1}{3}$ )**



KIAS

ALT MSL



5 5

5 5

10 10



TAS 72  
GS 72

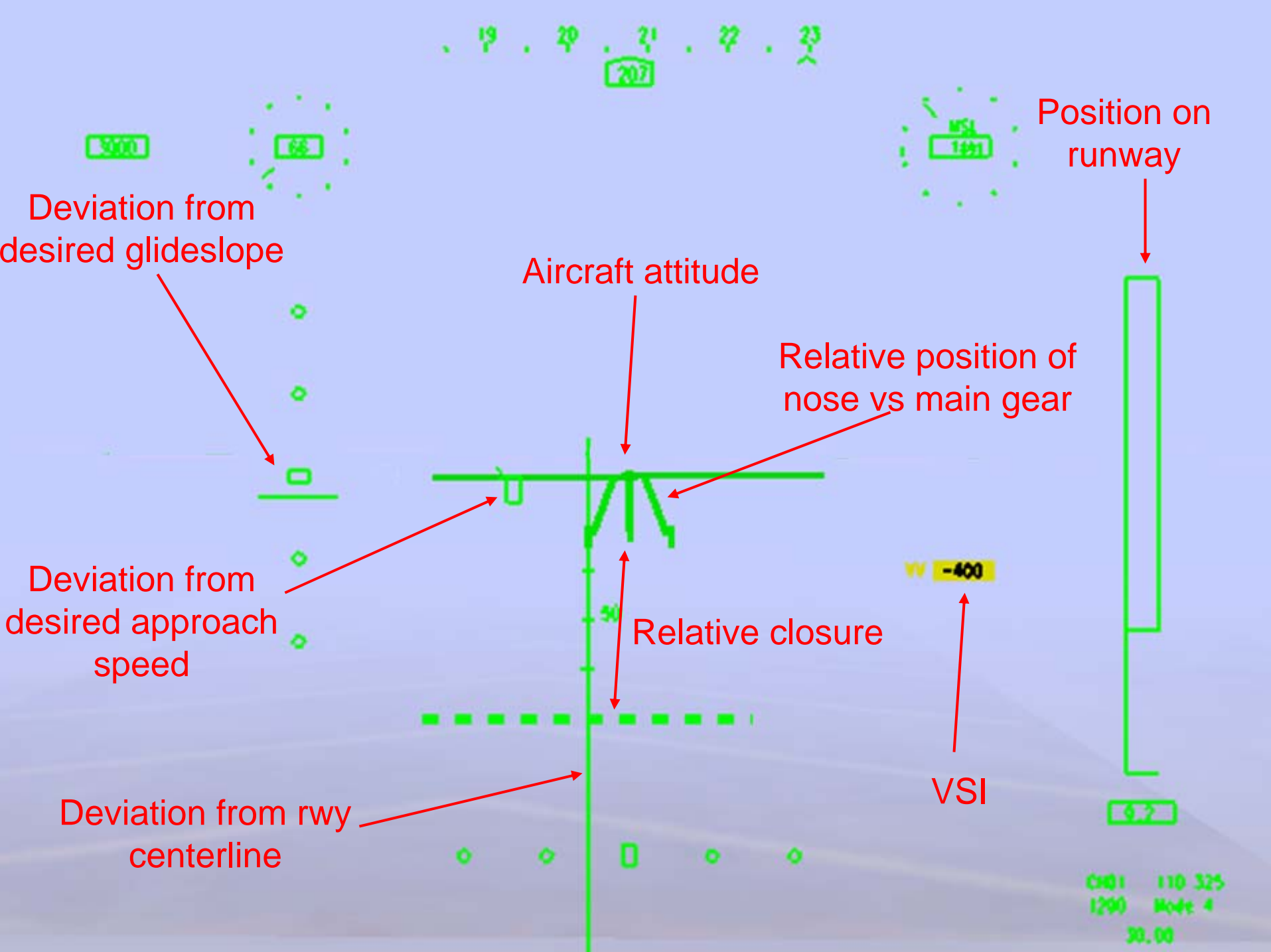
WV -314  
G 1.03

0.48

1200 Mode 4

CH01 110.325

30.00





# ***Needed: UAS HUD standards***



- **UAVs  $\neq$  derivatives of traditional aircraft**
  - **Sensory isolation**
  - **HUD is the total visual field**
  - **Predictive symbology**
  - **Symbology for autonomous monitoring**
  - **Multi-aircraft control**
- **Value of standards**
  - **Acquisitions**
  - **Reduce between-system variability**
  - **UAS integration into NAS**



# Questions

